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Learner's Guide

Course 5:
Advanced Metering:
Requirements and Best Practices

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Advanced Metering: Requirements and Best Practices

Background on the FEMP First Thursday Seminars

The First Thursday seminars are designed for Federal Energy Managers but are open to anyone whose scope of responsibility involves influencing decisions to increase energy efficiency, conserve water resources, and meet other Federal sustainability goals.

There are three ways to participate in the seminars.

1. Live streaming video available on the day of the event over the internet to a desktop computer or via a projection system in a conference room;
2. Digital and Analog Satellite downlink technology for group showings; and,
3. Archived streaming video available after the event over the internet on a desktop computer or via a projection system in a conference room.

To learn more about accessing specific seminars, access http://www.femp.energy.gov/training.

Introduction to the Seminar "Advanced Metering: Requirements and Best Practices"

The seminar **Advanced Metering: Requirements and Best Practices** is being offered live on Thursday, June 3, 2010 at 1:30 p.m. Eastern Time. For access and other course information, access: http://www.femp.energy.gov/training.

Course Description

In the **Advanced Metering: Requirements and Best Practices Seminar,** the following topics will be discussed.

- **What is "Advanced Metering"?**
- **Benefits of Advanced Metering**
- **Steps in Approaching Advanced Metering**
- **Types of Metering to Include Water, Air, Gas, Electricity, and Steam**
- **Selection Criteria for Metering**
- **Metering Communications**
- **Data Collection and Storage**
- **Case Studies**
- **The Future of Advanced Metering**

Audience

Advanced Metering: Requirements and Best Practices is designed for federal energy managers and other energy and environmental professionals who want to know more about advanced metering including requirements, metering technologies, best practices, and lessons learned.

Learner Objectives

After completing this seminar, you will be able to:

1. define advanced metering and discuss the potential benefits.
2. determine how to select advanced metering projects.
3. discuss advanced metering possibilities in terms of water, air, gas, electricity, and steam.

4. explain metering approaches - one time, run time, short term, and long term.
5. explain steps to an overall process for approaching advanced metering projects.
6. discuss some of the technological considerations when considering advanced metering including communications, data collection and storage, location of hardware, backup systems, and single vs. multiple vendors.
7. give examples of advanced metering technologies and selection criteria to consider.
8. talk about methods for evaluating advanced metering projects.
9. locate advanced metering resources.

Learning Resources

Legislative Basis for Advanced Metering

Requirement	Specifics
EPAct 2005	• Requires all Federal buildings to be metered by October 1, 2012, to ensure efficient energy use and reduce the cost of electricity used in Federal facilities. Advanced meters or metering devices must provide data at least daily and measure the consumption of electricity at least hourly. These devices must be used to the maximum extent practicable. • Requires Federal agencies to submit to the Department of Energy (DOE) an implementation plan identifying personnel responsible for achieving metering requirements, and any determination by the agency that advanced meters or metering systems are not practicable in their specific situation.
EISA 2007	Establishes a framework for facility project management and benchmarking. Agencies must identify all "covered facilities" that constitute at least 75% of the agency's facility energy use. An energy manager must be designated for each of these covered facilities. Each facility energy manager will be responsible for: • Completing comprehensive energy and water evaluations of 25% of covered facilities each year, so that an evaluation of each facility is completed at least once every four years. • Following up on implemented measures, including fully commissioning equipment, putting operation and maintenance (O&M) plans in place, and measuring and verifying energy and water savings. • Using a DOE Web application to certify and track compliance for energy and water evaluations, project implementation and follow up measures, and estimated cost and savings. The Web application will be available to Congress, other Federal agencies, and the public, with some specific data exempted from disclosure for national security purposes. • Entering energy use data for each metered building into a benchmarking system, such as the ENERGY STAR® Portfolio Manager. DOE must select or develop the benchmarking system and issue guidance for its use by December 19, 2008.

Resources for Advanced Metering

Guidance for Electric Metering in Federal Buildings
http://www1.eere.energy.gov/femp/pdfs/adv_metering.pdf

FEMP Operations and Maintenance (O&M) Best Practices Guide, Chapter 8- Metering for Operations and Maintenance
http://www1.eere.energy.gov/femp/pdfs/OM_8.pdf

FEMP Metering Best Practices: A Guide to Utility Resource Efficiency
http://www1.eere.energy.gov/femp/pdfs/mbpg.pdf

Definitions

Advanced meters: Advanced meters are those that have the capability to measure and record interval data (at least hourly for electricity), and communicate the data to a remote location in a format that can be easily integrated into an advanced metering system. EPAct Section 103 requires at least daily data collecting capability.

Advanced metering infrastructure: The communication's hardware and software and associated system and data management software that creates a network between advanced meters and utility business systems which allows collection and distribution of information and users.

Advanced metering system: A system that collects time-differentiated energy usage data from advanced meters via a network system on either an on-request or defined schedule basis. The system is capable of providing usage information on at least a daily basis and can support desired features and functionality related to energy-use management, procurement, and operations.

Amperes (amps): The measure of electricity flow in a conductor and usually measured with a ammeter or current transformer.

Automated Meter Reading (AMR): A form of advanced metering that uses communications devices to communicate data from the meter to the meter data-management provider. AMR may be used to transmit simple energy-use data from the meter, or to transmit more complex measures of energy recorded in the meter, or to implement advanced functionality, such as outage detection or remote programming.

Average demand: The demand on, or the power output of, an electric systems or any of its parts over and interval of time, determined by dividing the number of kilowatt hours by the number of hours in the interval.

British thermal unit (BTA): A commonly used unit of energy, specially for fuels or heat. A kilowatt hour is equal to approximately 3412 Btu. Quantity of heat required to raise one pound of water by one degree Fahrenheit or the equivalent amount of energy generated by burning a kitchen match.

Cooling loads: The energy required to achieve the desired (space cooling) temperature level.

Critical peak pricing: A type of dynamic pricing whereby the majority of kWh usage is priced on a time-of-use basis, but where certain hours on certain days where the system is experiencing high peak demand are subject to higher hourly energy prices that reflect market conditions for peak generation and delivery during peak demand periods. These critical period prices may be known to electricity customers under the conditions such as "day-ahead" or "hour ahead" and are typically employed a limited number of times per year.

Degree-days: The difference between the average temperature of any given day and a base temperature when the median temperature of the given day is (higher for cooling and lower for heating) than the base temperature.

Demand: A measure of the average real power over a specified time interval. Depending on the utility, the specified interval is between 5 minutes and 1 hour, with the 15 minute interval being the most common. The rate at which electricity is delivered by a system or part of a system, or to a load point or set of loads. It is measured in kilowatts, kilovolt amperes, or other suitable unit at a given instant or averaged over a designated time period.

Demand response: Demand response refers to the peak reduction of customer energy usage at times of peak usage in order to help address system reliability, reflect market conditions and pricing, and support infrastructure optimization or deferral. Demand response pricing may include dynamic pricing/tariffs, pricing responsive demand bidding, contractually obligated and voluntary curtailment, and direct load control/cycling.

Diversity: The diversity among customers' demand, which creates variations among the loads in distribution transformers, feeders, and substations at a given time. A load diversity is the difference between a maximum of two or more individual loads and the coincident or combined maximum load. It is usually measured in kilowatts.

Emission factor: The ratio of emissions to energy produced or fuel consumed, denominated in units of tons of emissions per unit of energy.

Energy audit: Analysis of a facility's electricity and other energy usage, often including recommendations to alter the customer's electric demand or reduce energy usage. An audit usually is based on a visit by an energy analyst or engineer to the home, building, or manufacturing or agricultural facility.

Energy charge: The charge for electric service based upon the amount of electric energy (kWh) consumed and billed under an applicable rate schedule.

Energy cost liability: Estimated future energy expenditures without energy savings improvements.

Energy management system: A full or partially computerized system designed to monitor and control energy use in order to achieve optimal efficiency.

Energy use index (EUI): Annual Btu/square foot energy use. The standard index used in most analyses to measure all fuel and energy used in a given building or group of buildings.

Energy: The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat this is then used as a transfer medium to mechanical or other means in order to accomplish tasks.

Harmonics: A measure of electrical frequencies beyond the fundamental frequency of 60 hertz and usually labeled as the first harmonic (60 hertz), the second harmonic (120 hertz), etc. Harmonics are created by non-linear loads that draw current in short pulses rather than the traditional smooth as sine wave form. Among other problems, harmonics can cause excessive heating of metal wires and certain types of electrical interference.

Hourly Metering: A type of interval metering where the measurement or recording of customer use is collected in 6 minute intervals. The competitive metering model is based upon the implementation of hourly metering of customers or the applications of load profiles, which average customer use over hourly periods.

Instantaneous peak demand: The demand at the instant of greatest load, usually determined from the readings of indicating meters or graphic meters.

Integrated demand: The summation of continuously varying instantaneous demands during a specified demand interval.

Interval metering: The measurement of customer energy used by fixed time periods or intervals. Typically, the interval time period is 15 minutes, but can vary according to customer or transmission and distribution system needs.

Kilowatt (kW): One thousand watts.

Load aggregation: Aggregation of energy consumption from facilities that are geographically separate from each other for purposes of acquiring and billing utility services.

Load factor: The ratio of the average load in kilowatts supplied during a given period to the peak or maximum load in kilowatts occurring during that period. Load factor may be calculated for a customer, customer class, or the entire electric system.

Load levelling: A process in which the energy demand can be temporarily reduced during certain periods. Typical examples include the intermittent operation of certain electrical equipment and shutting off equipment when rooms and buildings are not in use.

Load management: The controlling, by rescheduling or direct curtailments, of the power demands of customers or groups of customers in order to reduce the total load that a utility must meet at times of peak demand. Load management strategies reduce usage over larger multi-hour periods.

Load: The amount of electric power consumed at any specified point or points on a system. Load originates primarily in the power consuming equipment of the customers.

Net present value (NPV): The value of future energy savings -- less all project construction and operating costs, discounted to present value.

Peak demand: The largest value of demand occurring during the billing cycle. This value is typically used by the utility to assess peak demand billing. It is critical to understand how your utility assesses peak demand, and the associated kW charge, to be able to manage operational and economic efficiency.

Peak demand: The maximum rate of electricity consumptions, expressed in gigawatts. May be expressed for groups of electricity users or the whole system, and by season (summer or winter) or annually.

Peak load: The maximum anticipated demand for any given system.

Peaking unit or peaker: A generating station that is normally operated to provide power during maximum load periods.

Power factor: The ratio of “real power” (watts) to apparent power (voltage) and defined as the cosine of the phase angle between voltage and current.

Power Line Carrier (PLC): Communication system that transmits data between devices over power lines.

Real levelized cost: The uniform cost of electricity, in constant dollars, for which the present value of the electricity produced equals the present value of the costs of the plant.

Real-time pricing (RTP): The instantaneous pricing of electricity based on the cost of electricity available for use at the time the electricity is demanded by the customer.

Time of Use: The pricing of electricity based on the estimated cost of electricity during a particular time block.

Utility discount rate: A rate that reflects the utility's weighted costs of capital. Pre-tax, or more commonly, after tax.

Valley filling: The building of off-peak loads: An example of valley filling technology is thermal storage (water heating and/or space heating or cooling) that increases nighttime load and reduces peak period loads.

Volt -amperes (volt-amps): The measure of "apparent" rate of energy supplied to an electric load. The volt-amperes is defined as the voltage multiplied by the current. The volt-ampere is the metric used to rate many form of electrical equipment.

Voltage (volts): The measure of electric potential between two points in a circuit and typically measured with a voltmeter or potential transformer.

Volt-Amps Reactive (VAR): A measure of the system's reactive power or power stored in a system's inductive leas - and is mostly used for identifying power factor correction needs.

Watt: The electrical unit of power. The rate of energy transfer equivalent to 1 ampere flowing under a pressure of 1 volt at unity power factor.

Wattage (watts): A measure of the real power delivered to an electric load. Watts are defined as volt-amperes multiplied by the "power factor." As such, the real power will always be less than or equal to the apparent power.

Watt-hour: The total amount of energy used in one hour by a device that requires one watt of power for continuous operation Electric energy is commonly sold by the kilowatt hour.

Presentation Materials: Additional Information

Slide 2: What is Advanced metering?

Advanced meters – Advanced meters are those that have the capability to measure and record interval data (at least hourly for electricity) and communicate that data to a remote location in a format that can easily be integrated into an advanced metering system.

Advanced metering system – collects time-differentiated energy usage data from advanced meters via a network system on request or defined schedule basis.

Smart meter – smart meter is an advanced meter that utilizes real-time sensors to provide information on power consumption and price.

Slide 14: Metering Approaches

One time – useful in many baseline activities to understand instantaneous energy use, equipment performance, or loading.

Advantages: lowest cost, ease of use, non-intrusive; fast results.
Challenges: low accuracy, limited application, measures single operating parameter.

Run time – made in situations where hours-of-operation are the critical variable.

Advantages: low cost, easy to use, non-intrusive, useful for constant load devices;
Challenges: limited application, measures single operating parameter, requires additional calculations/assumptions.

Short term – combines both one time and run time into a time-series record or resource use: magnitude and duration.

Advantages – mid-level costs, can quantify magnitude and duration; fast results;
Challenges: mid-level accuracy, limited application; seasonal or occupational variance deficient; more difficult to install and monitor.

Long terms - makes use of time-series recording of resource but over a longer duration.

Advantages: highest accuracy, can quantify magnitude and duration, captures most variance.
Challenges: high cost, most difficult to install and monitor; time duration for result availability.

Slide 29: Communication Methods: Advantages and Disadvantages

Phone modem: Advantages: The oldest and most reliable, proven, secure and private network, usually available.
Challenges: can be expensive, no access to real time data, wired installation.

Local Area Network: Using the site's computer network can be very economic.

Advantages: proven technology, increasing availability, always connected, data sharing.
Challenges: Security concerns, wired installation.

Building Automation System – takes advantage of the site's previous investment.

Advantage: usually available; fast communications; always connected.
Challenges: compatibility issues, data availability issues.

Wireless: **Advantages –** Usually available; fast, always connected.
Challenges: system compatibility issues, data availability issues.

Power line carrier – Uses existing electrical wiring, both internal and external as the communication's conduit.

Advantages: uses existing infrastructure, always connected.
Challenges: speed of data transfer, technical issues with transferring data past transfers.